



Climate change adaptation: Linking indigenous knowledge with western science for effective adaptation

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ABSTRACT

The implementation of climate change response programmes for adaptation and resilience is anchored on western scientific knowledge. However, this has led to a tendency to marginalise indigenous knowledge as it is considered unimportant in this process (Belfer et al., 2017; Lesperance, 2017; Whitfield et al., 2015). Yet, knowledge systems rarely develop in isolation as they normally tend to cross-fertilize and benefit from each other. In this regard, we think that indigenous knowledge is just as important as scientific knowledge and the two must be integrated through multiple evidence base approach for climate change adaptation and mitigation. In this paper, focussing on African traditional society, we combine oral history with the available literature to examine traditional knowledge and awareness of climate change and related environmental risks. Interesting themes emerge from the knowledge holders themselves and our analysis uncovers a wide range of adaptive coping strategies applied with mixed success. From spotting and reading the position and shape of the 'new moon' to the interpretative correctness of its symbolism in "applied traditional climatology," and from rain-making rituals to conservation of wetlands and forests. Generally, findings seem to suggest that traditional African knowledge of environmental change may be as old as the society itself, with local knowledge transmitted from one generation to the next. Based on the perceived vulnerability of indigenous communities, many scholars tend to argue *generically* for the integration of indigenous knowledge into climate change policies and implementation (Ross, 2009; Maldonado et al., 2016; Etchart, 2017). In this paper however, we attempt to supplement these arguments by providing *specific and contextualised* evidence of indigenous knowledge linked to climate change adaptation. It is demonstrated that indigenous knowledge is neither singular nor universal, but rather, a voluminous, diverse and highly localised source of wisdom. We conclude that integration of such unique and *specific* indigenous knowledge systems into other evidence bases of knowledge, could be one of the best ways to the more effective and sustainable implementation of climate change adaptation strategies among target indigenous communities.

1. Introduction

Climate change is probably the most unprecedented global environmental challenge of our time. Its impacts are felt across all sectors and sections of society. Of these, the most directly affected is probably rain-fed agriculture (Culas, 2012; Sheffield et al., 2014); and because of this, indigenous communities dependent on agricultural livelihoods are likely to be the most affected. However, although indigenous people are already widely acknowledged as the most vulnerable to the impacts of climate change (Culas, 2012; Whitfield, 2015; UNFAO, 2011; Thomas and Twyman, 2005), their unique knowledge and experience remain largely under-utilised by interventions that aim to reduce vulnerability

or increase adaption to new circumstances. For example, the IPCC Working Groups (WGs) do realise the importance of indigenous knowledge and make attempts to include this knowledge. In the most recent reports (AR4, and AR5) engagement is however sometimes ignored or often limited in scope (e.g., in the physical science assessment by WGI; impacts, adaptation and vulnerability by WGII; and mitigation by WGIII). Yet the measures covered are designed for the most vulnerable, and indigenous communities in particular (Ford et al., 2016; Belfer et al., 2017) where local knowledge holders and expertise could be highly valuable. There are varied reasons for this negligence and omission, but many have been explained using lenses of critical political ecologies and discursive spaces (Robbins, 2012; Death, 2014; Mcdonell,

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2016; Belfer et al., 2017). Scholars have however demonstrated that there is much to learn from indigenous and community-based approaches to climate change adaptation, resilience and disaster preparedness (Thornton and Manasfi, 2010; Berkes, 2012). Borne out of their long-term experience and experimentation, indigenous people have often adapted to environmental change through techniques and approaches using knowledge transmitted both orally and in practice from one generation to the next (Salick and Byg, 2007; McDonnell, 2016). Through this process, they have been able to develop or enhance and maintain locally or regionally, a wide array of coping strategies (Tengö et al., 2014). Arguably, their knowledge and practices can provide an important basis for today's efforts in dealing with even greater challenges of climate change (Belfer et al., 2017; Fairhead et al., 2017).

Given the arguments above, and given that the climate has always been changing, albeit usually at rates slower than those currently being experienced (IPCC, 2014b), the aim of this study was to investigate how some of the indigenous peoples of the African continent have historically been adapting. There were two specific objectives of this study, to:

- i enhance understanding on indigenous peoples' coping and adaptation strategies to climate change;
- ii contribute to policy debates on intervention approaches by identifying areas of indigenous knowledge that could be integrated with other forms of knowledge (e.g., scientific) and understanding so that climate change adaptation could be sustainably enhanced.

2. Methodology

As part of the ongoing investigation on rural livelihood adaptation to climate change and knowledge complementarity anchored on multiple-evidence base (MEB) concept (Tengö et al., 2014), we extract, contextualise and discuss thematic areas that emerged from some of the oldest ethnic agriculturalists and pastoralists in the sub-Saharan Africa and the Sahel. We identified these themes from focus-groups and in-depth oral interviews conducted from 2016–2018. We looked for further evidence and validated these findings using secondary sources in the form of textual content. We further attempted a discourse assemblage in the discursive spaces on some of the indigenous knowledge contents and practices on coping with changes in environmental conditions and climate.

2.1. Selection of study area

The selection of the study area was based on past research on food security in the selected districts of Zambia (Makondo et al., 2014) and the observed population dynamics (CSO, 2010; Simatele and Simatele, 2015):

- All the 73 ethnic groups (except the Tonga) migrated into Zambia from various parts of southern, eastern, western and central Africa between 17th and 18th Century (Brelsford, 1965; Ohadike and Tesfaghiorgis, 1974);
- With formal employment rates at about 20 percent of the total population of 16.4 million, about 80 percent of the population is engaged in rural and natural resource-based livelihoods. The most prominent are small-scale farming, animal rearing, natural resources harvesting, hunting and fishing (CSO, 2015);
- Located in Central Africa and ranked among the most peaceful countries in Africa (IEP, 2014), Zambia continues to be a safe haven for migrants and refugees from war-ravaged and dictatorial regimes across the continent (UNHCR, 2015);
- Some of the oldest refugees and those without surviving family members in source countries have been integrated into Zambia as nationals, making Zambia one of the most diverse countries in Africa ethnically and culturally (Jacobsen, 2001).

2.2. Selection of respondents

Often, studies of indigenous knowledge have taken limited account of the diversity of expertise that may exist within this “blanket” term (Chalmers and Fabricius, 2007). We therefore aimed to explore this diversity, and the factors that lie behind it. With the help of local leaders, and relying on their “mental registers”, snowball sampling was used to arrive at 100 respondents regarded as local experts of traditional or indigenous knowledge, scattered across central and southern provinces of rural Zambia. These individuals were interviewed by asking simple questions such as: “do you know how people in your ethnic group were able to survive changes in environmental conditions and climate”, and/or “do you know of anyone who knows about this”? Depending on the feedback from these questions, and on age, livelihood, migration history/ethnicity and gender, a group of 18 participants knowledgeable about how people survived changes in environmental conditions and climate was arrived at. The 18 were considered and collectively believed to hold legitimate indigenous knowledge by the local community members themselves. Their age range was believed to be between 70 and 97 years as they did not have birth certificates. These represented 16 ethnic groups, 15 sub-Saharan, 3 Sahel descendants, comprising a near gender balance of 8 women and 10 men. Our core questions to individuals of this group were four-fold:

- According to local experts, how were the indigenous people able to cope from and adapt to changes in environmental conditions and climate in the past?
- How do their adaptation strategies compare to modern-day (scientific) approaches?
- With specific examples, please share what you think was not working well with indigenous adaptation?
- What do you think has not worked well with the modern-day approach?

2.3. Themes

The responses to the above interview questions covered broad and diverse themes. However, after analysing the responses, 11 thematic areas emerged. With follow-ups, clarifications and combining literature evidence, these were narrowed down to seven thematic areas since they were related. We outline and discuss these to highlight some of the evidence gathered on the approaches, techniques and mechanisms indigenous people claim to have drawn upon for centuries in climate change adaptation efforts in sub-Saharan and the Sahel.

3. Findings

3.1. Migration, traditional agroforestry and management of degraded farmlands

Moving from one place to another and closer to resources was important. From the interview responses, the concept of “proximity” or locating near sources of resources and “maintenance of available sources” for continued sustenance occurred frequently, suggesting high value attachment to these. Proximity may have also meant moving away from diminishing sources or those that could not be maintained and locating closer to the newly identified sources. Traditional agroforestry and management of degraded farmland partly determined the migration patterns as practices developed over centuries to cope from unproductive or degraded cropland, grazing pastures and diminishing stocks of fisheries.

This was found to be consistent with the evidence in the writings by Vickery (1986) and Chevo (2014). Coping and management strategies was largely anchored on swidden agriculture which involved shifting cultivation, prune or slash, coppicing and burning (Bayala et al., 2008; Ando and Shinjo, 2017). With swidden agronomy, remnant ash

obtained as a by-product from burning was used as a soil-conditioner for degraded farmland (Ando and Shinjo, 2017). As evidenced by findings in northern and central Zambia, the Bemba people originally from the Democratic Republic of the Congo (DRC) continue to use this technique where it is locally called “Chitemene”. As respondent SR 7 narrated:

Tree branches were coppiced-down on a small portion around an ant-hill and burnt. The stumps and uncut portions of the tree allowed re-growth while burnt trims yielded remnant ash used to mix with umushili (soil) to act both as repellent to termites and as fertilizer for cassava and pumpkin cultivation. During wild-fires, slashed and burnt portions acted as fire breakers (containment points). Cassava took 3–4 years to harvest, a period that allowed trimmed-trees to regenerate. After harvesting, cassava-tree branches were collected either as firewood, or burnt for more ash. This allowed a prolonged usage of the same piece of land before moving on to another ant-hill and coming back later, after 20 or so years. In those 20 years, the abandoned farmland also acted as range land for grazing livestock.

Pastoralists also migrated at certain times of the year and came back at another time of the year after covering long distances in search of pasture. This seasonal or circular migration pattern can be considered as a traditional positive adaptation strategy for seasonal climate variabilities. Yes, there may be limits within certain thresholds of livestock and human population numbers to which such movements become restricted. However, these limits are mutable as issues such as values, ethics, risk, knowledge and culture construct societal limits to adaptation (Adger et al., 2009). Significant seasonal migration is still very common among some ethnic groups in the Sahel and sub-Saharan Africa. These include the Tuareg and Fulani in Mali, Chad, Niger, and Mauritania (UNEP, 2011), the Basarwa and Khoisan of sub-Saharan Africa in Namibia, Botswana and South Africa (Sporton et al., 1999), and the Lozi and Ila in Zambia (Mwanangombe, 2010). There may be significant lessons to learn from these for future adaptation needs.

3.2. Social networks: relief support against food shortages and hunger

What emerged from interviews and culminate into this theme was the interdependence nature of households and communities in times of adversity, uncertainty and misfortune. Interdependence was found to be highly valued and integrated into everyday proverbs and teachings. As put by Respondent SR 8 in proverbial terms: “*tende ngulembwe amazuba ngunamasandu*” (we can never be so sure at dusk about how our feet will tread tomorrow, as each day at dawn comes with surprises); “*aceeco tabali boonse basimunya baweza buyani, pesi balalya kumukwashi buce-buce*” (and that is why even in the insects kingdom, not all ants come back with prey after hunting, but through comradeship, they are able to feed with those fortunate with prey. These proverbs emphasise a deep sense of interdependence and unconditional support, such that the one who has no sense of sharing or respect for collective responsibility in the community, is considered incapable of building a family.

As Mazrui (1986) argues, there are probably no other communities that have been more socialistic in approach to livelihoods than an African society. Partnerships have existed for hundreds of years with extended families living together, with a concept of safety in numbers characterising a complex customary land ownership system (Mazrui, 1986; Platteau, 1996; Brasselle et al., 2002). The support networks started from the extended family system through to the neighbouring community and kinship. To maintain community cohesion, related families located or migrated closer to each other as part of a larger family, extending into clans and communities (Mazrui, 1986). In good harvest years, community members donated extra crop-yields and livestock to the kinship, who in times of distress and great difficulty donated to needy families, widows and orphans. The community shared

everything, from a piece of land for cultivation to seeds for planting, and from food in the pot to water in the cup (Mazrui, 1986; Vickery, 1986). Similar behaviours in distressful ancient times among a general human species have been observed. A spirit of resource sharing has been one of the most important ways through which both ancient and modern indigenous communities have been able to adapt, build resilience and solidarity against food shortages in the face of environmental change (Salick and Byg, 2007). Today, despite mixed cultural influences leading to a more individualistic approach to livelihoods, the African society is still characterised by extended family support networks (Ratha et al., 2011; Adams and Cuecuecha, 2013; Mushinge and Mulenga, 2016). For example, this research found that households of related families lived closer to each other, connected by family lineage along clanship and larger extended communities. These families relied on same customary land, sharing tools for crop production including harvests.

3.3. Changing eating habits/diets

Like interdependence that gives rise to social networks, the theme of changing eating habits emerged from managing scarcity. This was highly regarded by the traditional knowledge holders and was integrated into every day teachings. When people have been faced with hunger and did not have access to certain foods, there is evidence to suggest that changes in diet and the forms of food utilised can be accommodated easily. As Respondent RS8 put it “*shyuumbwa cakamulisya bwizu bana bakwe takabakacizyibi paka bakakomene, pele muvwimi ulizyi kuti cakalishya shyuumbwa bwizu ni nzala*” (what made a lioness eat grass will never be clear to its cubs until they are grown, but a hunter knows that so many things can force a lioness to eat grass, among them, lack of prey and hunger itself, stomach upset and indigestion).

Work in East Africa by Rufino et al (2013) attest to this social behaviour with compelling evidence. Within two to three decades, staple diets changed from being dominated by bananas to being maize-based, because frequent droughts, pests, diseases and a declines in soil fertility led to the decline in banana productivity (Rufino et al., 2013). Alternatively, people preferred maize because it was then considered easier to store and needed less growing period than bananas. A similar observation has been made in Ghana, DRC, and Nigeria where yams (tubers) are slowly being replaced by cassava, rice and maize (Chima, 2007; Nweke, 2017). In Zambia, rural communities in the southern part of the country that relied heavily on maize, now grow drought resistant food crops such as cassava and millet which they rely on during times of low maize yields (UNDP and GRZ, 2010; Smale et al., 2015). Similar practices have been cited in Zimbabwe (Chimhowu and Hulme, 2006)

3.4. Spirituality and taboos

Consistent appearance in responses under different guises, such as assumed invisible power of ancestors, value accorded to divine intercessors through sacred places, punishment from the invisible judge, or forgiveness through offering, this theme emerged to combine this line of thought. There is strong evidence to suggest that spirituality and taboos are possibly tacit rules for resource governance that encourage collective efforts in responsible resource utilisation, protection and nature preservation. The extent of sacrifice to invisible powers for instance, suggests a deep sense of remorse for failure to obey these tacit rules believed to guide the peaceful interactions and cordial relationships between the living and the dead; and nature or environment and the living.

This “spirituality” comprising traditional practices has far reaching benefits in resilience building in many cultures and as both Cutter et al (2008) and Mowbray (2012) have shown, the human spirit of resilience is often invoked by what cannot be changed. While spiritual solace is not adaptation *per se*, it has been a useful form of cultural capital that influenced and shaped the perception of risk and shock (TAF, 2012).

After shock, the first thing people usually did was to accept that it was impossible to change what had happened. With that recognition came the realisation that picking-up from what was left and moving on was inevitable (Mowbray, 2012). Spiritual solace is well documented in many indigenous communities across continents (Saha, 1994; Elias et al., 2005; TAF, 2012; UNEP, 2011). As a form of managing shocks and losses, people relied upon their spirituality to re-organise, offer themselves emotional comfort and accept unchangeable circumstances. In Africa, literature evidence suggests that people did not usually recognise their own agency in the causal-effect scenarios of nature's calamities. They attributed everything to the wrath of the offended gods or ancestors (Haruna, 1997; Colson, 2006; Murphy et al., 2016; McPherson et al., 2016), accepting negative changes as a consequence of wrongdoing. Wrongs included failure to protect forests, river systems, help the needy within the communities in the times of difficulty. Spirituality defined this perception (largely based on tacit rules) and made it possible for surviving communities to pick-up from what was left from a disaster. They recommitted their energy with hope to nature conservation and togetherness (Elias et al., 2005). As the oldest respondent RS 2 succinctly put it:

In traditional spirituality, our departed ancestors and gods of the rain handed down punishment under two circumstances: when people abused natural creation, or when they failed to take care of one another. Both taboos could only be corrected by offerings and sacrifices: It was a tradition and a spotless black or white goat with beer by the Mukula tree (Mahogany/Rosewood) at dusk cleansed the earth. But, with the coming of Christianity which brought colonialism, all this was considered as evil. At baptism with missionaries, people were asked to affirm they have discarded all these practices. See what we have today; anyone can cut down trees around malende (dambo and its catchment area), we now have so many droughts, crops can't grow, the soils can't germinate seeds, and our future is uncertain: the gods and our ancestors must be having their last laugh, we are disconnected, and the youth have left to the city, leaving old and dying men to till the land.

Farming was slowly considered as risk undertaking (Below et al., 2014; Makondo et al., 2014). As Bryceson and Fonseca (2006) argued, this process of 'de-agrarianisation', was spreading. There was a strong growing trend from indigenous small-scale farmers to re-orient economic activity away from farming, or alternatively relocate into urban settings. Youths have continued to migrate to cities for trading activities, leaving the older generation to farm the land. The low and uncertain income returns from smallholder production leave even the uneducated youth with less options, other than to seek alternatives to farming (Bryceson et al., 2007).

3.5. Ecosystem services and resource utilisation

The ecosystem services and resource utilisation theme emerged from the "close attachment to nature" conceptualisation by the indigenous' daily living and the ability (or lack of) to utilise this attachment. Responses showed how much dependence there was on nature in everyday lives and how compromising that relationship spiritually or otherwise was not accepted. From medicines to construction materials through to reading the moon (wrongly or correctly), or siting long-term sources of water, indigenous lives show a strongly tied dependence to ecosystems services, presenting a somewhat different human-nature nexus domain: one of overdependence. As findings revealed, their lives evolved around nature in nearly every aspect.

Indigenous communities have tended to migrate and locate into semi-wet lands as a form of strategy to cope with drought (Scoones, 1991; Sichingabula, 1998; Worldbank, 2009). For this reason, semi-wet lands such as dambos have been of great importance to food-crop production. Dambos are seasonally waterlogged, grassy depressions found in river basins surrounding most southern and central Africa

streams and rivers into which fluvial materials from runoff and seepage collect (Scoones, 1991). Given their high moisture retention and organic matter content, dambos have been key land resources for sustaining production of both crop-agriculture and pastoral systems. In this investigation, findings suggest that as a coping strategy from poor soils, droughts and rainfall variabilities, both dambos and uplands are still being used (in an integrated manner) to ensure food-crop production and livestock grazing. In both southern and central provinces of Zambia, small-scale and commercial farmers utilise these zones. However, when these form part of the flood plain, they can expose both crops, cultivators and their livestock to a new set of environmental shocks (Conway et al., 1983; Dumeni and Obeng, 2016).

With water shortages, literature evidence suggests that as people became aware of any major drought threat, extending water usage (reduce, recycle or reuse) was prioritised as a coping strategy to evade such phenomena (Colson, 2006; Mwanangombe, 2010). Traditional "climatologists" are also believed to have known and conceptualised the relationship between the moon's position and rainfall occurrence. Arguably, they were able to predict droughts or floods by reading the moon's shape and its position. Whether this relationship was correctly interpreted or not, it was a "disaster warning tool" that gave guidance on when to migrate to safer ground during floods (Mwanangombe, 2010), or to dambo zones during droughts (Gyampoh et al., 2008, 2009). Shifting from one drier zone to a wetter zone during droughts, and doing the opposite in times of floods helped indigenous communities escape droughts and floods (Mwanangombe, 2010; UNEP, 2011). The claims by Colson (2006) and Mwanangombe (2010) seem supported by transcribed interview data. For instance, respondent SR 6 stated:

In those days, because of water challenges, the water initially used to wash vegetables, fruits and pots was reserved. It was kept either for irrigating gardens or left out on the open as drinking water for smaller domestic animals and poultry.

On climate and disaster management responses, traditional climatologists were valued in the circular migration strategies as respondent SR 2 narrated:

In ancient tradition, the position and orientation of the new moon crescent spoke a language understood by rainmakers of that time. It signified either doom or gloom. The tilted u-shaped of the moon symbolised flooding. With flooding, water-borne related illnesses were eminent. Conversely, the stable shape promised plenty and good health.

Water table fluctuations were monitored using hand-dug wells which were sited and positioned using sediments and vegetation bio-markers. This traditional skill continues to be practiced by the Tonga people in Zambia (Saha, 1994) as respondent SR3 affirmed:

By looking at the type and quality of vegetation and the soils that lie beneath, siting water wells, identifying good quality grazing land and type of game became part of your everyday life. You learnt this skill at birth, through observation of your father and village elders. Ultimately, the skill became intrinsically entrenched in you as the same water in trees and rivers flowed in your blood.

This ability to identify long-term sources of water was very important. Similarly, as a direct coping mechanism, the rationing of water and economical use of other related resources reduced wastage and it has been documented in many parts of sub-Saharan and Sahel Africa (UNEP, 2011). Osbahr et al (2008) encountered this strategy in Mozambique where supplementary activities in households included picking wild fruits or plants and collection of fodder for kraaled animals. These practices potentially result in minimal wastage of resources, thrift preservation of assets and reduced expenditure. However, these practices were usually abandoned as soon as the first good rains began (Osbahr et al., 2008), but as a behavioural change strategy,

they helped communities in managing scarcity in hard times.

3.6. Rainwater harvesting and rain-making

The rainwater harvesting and rain-making theme emerged from terminologies such as *musena* or dambos, siting water sources, and the ritualization of rain through sacred places or shrines. Rain shrines are perennial wetlands considered as holy sites, divine and sacred natural designs because of their associations with biodiversity and a life sustaining system -water. Rainmaking especially through shrines appeared to have been one of great importance: a life support system for both biodiversity and human survival. Local knowledge holders explained how water has been sought after in living memory and why shrines tended to be the ultimate answer to the water scarcity question. Although communities were unable to harvest enough rainwater under poor rainfall periods, rainwater harvesting, a traditional way of diverting, impounding or collecting and storing rainwater was practiced for domestic use and food-crop production.

Rainwater harvesting and rain-making has continued to be practiced in many parts of Africa (Lebel et al., 2015; Owen and Goldin, 2015). The practice, which was also usually abandoned with more than adequate rainfall (possibly to manage flooding) is being revitalised. For instance donor funding agencies operate and promote rain-harvesting projects in rural communities in sub-Saharan and the Sahel to manage droughts and rainfall variabilities resulting in frequent intermittent drying-up of wells (UNEP, 2011). Similarly, the formation of rainwater harvesting networks in southern Africa particularly in Botswana, Namibia, Zambia and Zimbabwe is also a response to frequent droughts in the region (Lebel et al., 2015; Owen and Goldin, 2015; Botha et al., 2015). Within these countries, traditional beliefs and rituals for rain-making have been documented (Byceson and Fonseca, 2006; Siamonga, 2015). For instance, rain shrines are still highly regarded among the indigenous peoples of southern Africa. They are still considered largely as places where the gods of the rains reside and are sources of food not only for the local communities, but also for their fallen ancestors and the gods (Murphy et al., 2016). There was no cutting down of trees along streams and on the river catchment (Murphy et al., 2016; Antwi-Agyei et al., 2014). In this regard, conducting and harmful activities such as cutting down trees or migrating into or near perennial wetlands was frowned upon. As respondent SR1 recounted,

The malende (dambos and its catchment) at Gonde for example were very important, and still so even today, although they have been trivialised. These were places of worship where rain priests talked directly to the god of the rains. If the basangu (angels and oracles) were in good mood, borne out of an exemplary community standing with the gods, it would start raining before rain rituals ended. At the end of every, the malende oracles were consulted about the rainfall situation in the year ahead.

Rain-making practices are widely documented on the African continent: for instance in West Africa (Haruna, 1997; Gyampoh et al., 2009; Cobbinah and Anane, 2016); Southern Africa (Jarvis, 2013; Siamonga, 2015) and parts of eastern Africa (Akong'a, 1987; Sanders, 2008). However, the observation of traditional rain-making has declined (Siamonga, 2015). As respondent SR5 concluded, *"today this (Christianity) is a sensitive issue in communities and some of the traditional practices considered useful have been abandoned: they are now interpreted as witchcraft."*

3.7. Energy, forests conservation and healing

Related to the theme of migration and ecosystem services is energy, forestry conservation and herbal-based medicines. As the gathered evidence from interviews seem to suggest, forestry resources have a dual importance in African traditional societies. This theme therefore

emerged to separately outline and discuss the dual importance of forest resources (i.e., biomass energy, and herbal healing) and the traditional conservation of these for continued access to benefits and sustenance associated with them. During fieldwork, we also witnessed first-hand the importance of forest resources as all the respondents that formed the basis of this investigation had no access to electricity or medical care insurance. They relied either on firewood and charcoal for cooking and heating; and only relied on clinical medicine in extreme illnesses. To them, a healthy forest is as important as a health human life and the need for ecosystems services and their protection was highly rated.

Just like the rivers, the trees and all that which lives in the thickets is as important as human life. Traditional experimentation taught our ancestors the linkages between rainfall, forests, game and food for mankind. Trees are a source of healing not only to life in human form, but to soils and the air and the blossoms of life that live in them Respondent SR 4.

Energy needs continues to push people towards forest land as firewood and charcoal were the main sources of domestic energy. As findings suggest, this practice remain common in Africa and Zambia in particular. However, with competing demands for agriculture and biomass energy, forestry resources continue to be under pressure as deforestation continues. Related to forestry, African traditional medicine is perhaps the oldest and most varied of all therapeutic systems (Gurib-Fakim, 2006). In their various forms, these healing practices have been framed to potentially offer a holistic approach to both the body and the mind (Mahomoodally, 2013) although their continued use is arguably linked to cultural and economic reasons. People use traditional medicine when they cannot afford clinical care (Chintamunnee and Mahomoodally, 2012). However, Plants with healing properties have been traded for hundreds of years in different parts of Africa, diversifying income sources while stimulating conservation in the process (Gurib-Fakim, 2006; van Wyk, 2008; Rana et al., 2014). In this research, the use of traditional medicines were found to be common among rural communities in Zambia. Herbal medicines were orally taken or ingested in the mix with food. They were also found traded openly in informal local markets. The need for herbal healing may have indirectly drove conservation agendas on forests and the protection of specific plant species with medicinal properties.

4. Discussion

Despite significant seasonal and annual rainfall variabilities, erratic crop yields, poor soils, and depleted natural resources; rain-fed agriculture, herding and fishing remain the dominant livelihood activities in rural Africa (Worldbank, 2009; UNEP, 2011). As demonstrated in this paper, indigenous societies adapted and managed unproductive or degraded farmlands based on their own long-term experience (Vickery, 1986; Chevo, 2014). Without any sophisticated equipment, they identified and distinguished fertile soils from poor ones, sited long-term source of water and cultivated land with basic methods that arguably, had limited impacts on forests or wetlands (Vickery, 1986). A shift from traditional conservation farming was instigated with the arrival of missionaries leading to colonialism. Indigenous communities that practiced certain traditional forms of agronomy found themselves persuaded to adopt new approaches and voluntary extension initiatives to enhance their farmland productivity (Mazrui, 1986; Colson, 1971). For instance, when the first Christian missionaries arrived in 1903 in southern Zambia, the indigenous people (having practiced successful agronomy and pastoralism) became the perfect pilot cohort for extension cultivation initiatives by colonialists. Commenting in his first report to the Jesuits Catholic Order, Fr. Joseph Moreau described the Tonga as a sustainable social formation of peaceful domestic communities, with a clearly distinguishable mode of production for self-sustenance dominated by agriculture and pastoralism using simple tools and human strength as the main source of power (Vickery, 1986). As

Hogendorn (1975) remarked: “it’s true that early European observers exaggerated the degree of devastation experienced; they cherished a ‘liberator’ self-image and developed a stereotype of the ‘mild or ‘docile’ (indigenous), an image often contradicted by actual behaviour in the colonial period” (Hogendorn, 1975, p. 291).

70 years later, the people of southern Zambia were again subjected to a second wave of extension initiatives, the “green revolution” and this time, by the Zambian government (Chevo, 2014). In the colonial period, the aim of extension initiatives and diagnostic-prescription-intervention models were introduced to build capacity for communities to increase agricultural production and lower food prices (Dawson et al., 2016). Post-independence, this agenda was inherited with the same aim and applied in the same manner by African governments themselves. Intervention approach continued to be top-down persuading communities to accept new methods and technologies. In prescribing solutions, government technical officers rather than communities identified problems; then technical considerations took priority over economic considerations (Tiffen et al., 1994). The approach in climate change adaptation programmes seems to be anchored on a similar platform insofar as the diagnostic-prescription-intervention model is concerned. Experts diagnose local problems and prescribe solutions based on their worldviews. However, if lessons from analyses of agricultural extension initiatives are anything to go by, disenchantment and resentment can result among communities when technologies promoted for adoption are regarded as inappropriate solutions to inaccurately diagnosed problems (Tiffen et al., 1994; Blaikie, 1985; Simtowe and Muange, 2013; Dawson et al., 2016).

Based on human population dynamics and natural resource economics, swidden agriculture and similar strategies have attracted criticisms in the literature driving conservation agendas (Adomako and Ampadu, 2015). For instance, swidden agriculture, a form of agroforestry has largely been stereotyped as “slash and burn” by modern critics and the media. Slash and burn is a term rooted in the scientific and colonial encounter of 18–19th Century (Thrupp et al., 1997). However, as a form of agronomy, swidden agriculture may have allowed faster forestry regeneration than today’s extensive commercial agriculture, which clears considerably larger areas of forest cover (Rueda, 2012). Indigenous people have lived sustainably with nature for centuries using spirituality and taboo as tacit governance mechanisms (Tengö et al., 2007). For instance, restrictions on cutting down trees around wetlands and river systems may have been nothing but a traditional conservation strategy. This management strategy maintained wetlands, river systems and associated resources. Similarly, cultivation managed forestry resources. For example, while using ash as soil conditioner on degraded farmlands, swidden agriculture may have prevented desertification, thereby preserving forest habitat against environmental impacts more than would be if uncontrolled wild-fires engulfed untrimmed forest (Ando and Shinjo, 2017). The Bemba of northern Zambia and DRC have used these methods for centuries. Forests in these areas are not as depleted as in the southern part of Zambia where modern farming techniques resulted in a semi-arid environment where nothing can grow without fertilizer. From the IPCC reports, we know that climate change driven by deforestation and fossil-fuel carbon emissions are far greater in magnitude and speed of onset than anything previously known in the Holocene or indeed in human history (IPCC, 2014a). The contribution to these emissions is lowest among indigenous peoples (IPCC, 2014b).

Traditional swidden agroforestry allowed a sustainable tree regeneration process that protected crops from harsh climatic conditions such as extreme heat and wind storms (Teklehaimanot, 2004). Trees are more resistant to drought and rainfall variability than crops. Pruning prevented the negative effects of tree-shade on adjacent crops (Le Houérou, 2000) while decomposing organic matter maintained moisture in soil during droughts (Bockstaller et al., 1997; Bayala et al., 2008). Swidden farmers understood this relationship. For example, acacia (*faidherbia albida*) leaves were known to produce fodder which

not only supported livestock during the dry season, but also fertilized farmlands from the decomposition process of remnant leaves giving off nitrogen (Teklehaimanot, 2004). The point we are making is that such knowledge as a means of adaptation, can be integrated and scaled-up for sustainability and resource efficiency in resilience and agroforestry or conservation agricultural innovation programmes. For example, crop-yield remnants such as folder can be used as cattle feed, and by-products (cattle manure) used as a soil conditioner or to produce another biogas, resulting in closed-loop resource efficiency.

Thus, swidden agriculture may not result in forest depletion with increasing populations, if managed sustainably (e.g., integrating with scientific approaches). It has the potential to offer long-term benefits to livelihoods and conservation agendas. Perhaps the question should be: how does the environmental footprint of traditional adaptation strategies compare with what may be termed as elite-centric top-down strategies?

The idea that increasing populations can increase deforestation and result in environmental degradation may not always be true. This has been illustrated in the now-classic rural Kenyan study of Tiffen et al (1994). Although the study has been criticised as a “miracle” for lack of replicability (Siedenburg, 2006), it shows that as population increased in Machakos, conservation outcome improved resulting in less land degradation and more robust soil erosion containment. Natural resource-based livelihoods flourished along conservation and agriculture, supplementing income sources as forestry resources were traded either as energy, fibre or building materials (Tiffen et al., 1994). With population increase, destruction of the commons did not happen in Machakos. Instead, forestry conservation and population increase became positively correlated. Deforestation, soil erosion, energy needs and food challenges were addressed simultaneously by locally organised knowledge. Such means of adaptation and resilience are important as closed-loop approaches to resource utilisation: they can greatly enhance sustainability in the face of climate change.

Flexibility in changing eating habits can be taken advantage of by scientific knowledge. With consultations of indigenous people’s preferences, more sustainable food choices can be integrated with diversification. Diversification increases both efficiency of farming systems and builds resilience to climate change as it spreads the risk, providing an increased economic resilience at farm or local level. Diversified crop rotation (e.g., combination of leguminous plants, including crop varieties and species with different temperature, nutrients requirements and resistance to pests or disease) coupled with water use efficiency enhances the effectiveness for reducing risks and increase efficiency among rural farmers (FAO, 2010). Similarly, combining crop-cultivation and livestock rearing is a useful adaptation approach and a means for resilience building against climate related uncertainties (Scoones et al., 2013; Thornton and Herrero, 2015). It is evident in literature that diversification of farming systems reduces vulnerability and strengthens resilience of rural communities to climate-related shocks (UNEP, 2011; FAO, 2010; Arslan et al., 2015; Ngoma et al., 2015). However, if recipient communities are not involved in making these choices, no matter how efficient the farming system may be, acceptance remains subject to local preferences. For example, after the Tonga people of southern Zambia lost most of their cattle to East Coast fever disease, the government introduced donkeys (*Equus asinus*) as an alternative, resistant to both drought and disease. However, having reared cattle for centuries, this gesture was outrightly rejected by the Tonga because they did not subscribe culturally to the use of donkeys (MoA, 2003). As Vickery (1986) recounted in her ethnographic work among this ethnic group now found in Malawi, Zimbabwe, Zambia and Mozambique, both the lived-lifestyle and archaeological evidence indicate a basic cultural heritage continuity based on rearing cattle, nature conservation and crop cultivation. This tradition dates back to the fifth century A.D., and is believed to have been eroded and destroyed by European contacts in 19th Century and government policies thereafter (Hogendorn, 1975).



Fig. 1. A 400+ years baobab tree conserved by indigenous people in southern Zambia signifying conservation (2017).

Globally, indigenous peoples have generally shown detailed local ecological knowledge about biodiversity and value which can be tapped for greater impact conservation (Colson, 1971; Saha, 1994; Elias et al., 2005; Gyampoh et al., 2009; McPherson et al., 2016). The baobab tree in Fig. 1 (nick-named by indigenous people as *Ngombe Illede* -sleeping cow) exemplifies a conservation practice that has taken place for centuries which also served as a trading centre for more than 100 years between the Arabs and indigenous communities. Considered a community resource and shrine, it remains undisturbed by human activities after 400 years (McIntosh and Fagan, 2017). However, most of the wetland shrines have disappeared and the baobab tree in question is now a protected site by the Heritage and Conservation Commission of Zambia. The argument we are making is that integrating invaluable traditional ecological knowledge into the main-stream science is important. From these arguments emerge four broad critical features of knowledge integration that may enable a more productive and mutually beneficial relationship between and among different knowledge systems. These are: identification of new frameworks for integration, greater cognizance of the social contexts of integration, expanding modes of knowledge evaluation, and more involvement of inter-cultural “knowledge bridgers” (Bohensky and Maru, 2011). These can be achieved through multiple-evidence base approach (Tengö et al., 2014).

5. Conclusion

To indigenous communities, there is nothing new about climate change. These communities have lived with and adapted to it for centuries (Bridges and McClatchey, 2009; Etchart, 2017). The life of mobility of pastoral and hunter-gatherers constitutes a traditional response to seasonal and drought-induced shortages of water and food. Without mobility, supplemented by other traditional practices of kinship and support networks, it would have been unlikely that opportunities for occupation of the arid zones such as the Kalahari would have occurred (Sporton et al., 1999). Similarly, over much of the Sahel which has been extensively dry for centuries, opportunities for food-crop cultivation have been slim: pastoralism have traditionally turned to be the most viable livelihood (UNEP, 2011). However, what is new to people living in these and other regions referred to in this study is the accelerated anthropogenically induced climate change (Ross, 2009). As consensus

ties adaptive capacity to sustainable livelihoods capital (e.g., information technology, material resources, infrastructure, institutions and entitlements) indigenous peoples worldwide are found to be the most vulnerable to even small changes in climate (McLeman and Hunter, 2010; White, 2012; Bryceson et al., 2003; Connolly-Boutin and Smit, 2016).

There is no doubt that adaptation and mitigation efforts in addressing climate change are essential, but as Whitfield (2015), Lesperance (2017); and Belfer et al (2017) have shown, the concern that such efforts and actions may be perpetuating marginalization need be addressed. If they remain unaddressed, they are likely to increase vulnerability as adaptation agendas continue with little or no reflection of the worldviews, needs, and rights of indigenous communities (Maldonado et al., 2016). Recognising this concern, this paper has attempted to highlight some of the coping strategies used by populations amidst adversity of climate change and related environmental stresses. Certainly, not useful in every context. For example, seasonal migration and nomadism no longer provide certainty that those migrating into new areas are free from any environmental risk, or that those who remain are any safer (Morrissey, 2013; UK-GOS, 2010). But by highlighting some of these strategies, we hope to have brought forth to the global climate change and conservation agenda and debate, a view of a uniquely positioned cultural capital base that may be useful to both the policy maker and the knowledge bridger. Yes, past prescription may have solved some urgent problems here and there, but without local people’s cultural capital injection; without working closely with communities and integrating their local knowledge into such projects, sustainability is brought into question. There is only so far such a prescription-approach can go before becoming self-defeating as there is no guarantee that the imposed solutions will be continued by the target group after project financial support is no longer available. Thus, while indigenous communities may undoubtedly need significant support to adapt to climate change using scientific knowledge, they have knowledge of coping (Berkes, 2012). The identification through the multiple evidence base approach proposed by Tengö et al (2014) and the integration of this evidence into the main-stream science agenda, potentially promises to provide one of the surest ways for the development of more effective and sustainable strategies. Modern problems cannot be solved with singular, mechanistic, science-centred solutions alone. The impetus behind this work remains to invite an open and

honest dialogue within MEB approach and scholarship which recognises that knowledge systems do not develop in isolation. Integrating different knowledge systems has great potential to back environmental change adaptation and conservation agendas at different scales but with global benefits.

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